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INTRODUCTION

Numerical simulations which require High-Performance Computing (HPC) are more and more used in all the fields of industry, yielding performance improvement for numerous products.

This trend is similar in sports, especially when material and technology are involved. Numerical simulations become useful tools as performance aids: from weather forecast to estimate snow quality on the skiing track to use the best possible wax to Formula One racing car for which a lot of optimisation (aerodynamics, structure, combustion...) are carried out thanks to great power computer.

Nautical sports are not left behind, especially in sailing, where the design workflow is similar to the one used in the industry, since some of classes can afford skills, tools and computer power, as for the America's cup. Rowing and kayaking do not benefit from such a financial support. However, from the hydrodynamic point of view, they have some specificities which make them challenging: the athlete who is the propulsive machine has a great interaction with the system and uses blades which generate a violent unsteady flow near the free surface. Futhermore, the unsteadiness of the propulsion associated to the motion of the athlete with respect to his hull leads to large secondary motions which are a singular feature for the flow around hulls in calm water in hydrodynamics.

RESULTS, DISCUSSIONS AND PERSPECTIVES

In this communication, we will present recent works adressing some of the scientific challenges described below. For the flow around rowing blades, a validation procedure has been initiated using both an instrumented boat and an experimental database from a measurement campaign in the towing tank of ECN with a dedicated device able to reproduce a simplified rowing stroke with a full scale oar ([2]). Comparisons with unsteady CFD simulations including the flexibility of the oar show that it is possible to reproduce accurately the physics of such a complex flow generated at the laboratory where conditions are well mastered. Since the physics of this flow is similar to a real rowing stroke, the larger discrepancies obtained with the instrumented boat may be imputed to a lack of accuracy of the measured blade kinematics. Without accurate and reliable experimental database studying the unsteadiness of the flow around rowing and kayak hull, the validation of this flow is left open until now, and the accuracy of the turbulence model for this specific flow remains questionable. However, indirect validation may be carried out once a model of the whole system (hull+oar+rower) will be available. This task is under progress. The rower is modeled through a multi-body dynamics whose kinematics is imposed through a style modeler ([1]). A coupled resolution of the flows around both the blade and the hull including the interaction with the imposed motion of the rower is planed. Then, comparison using some in-situ measurement may be done. The major issue will be the matching of the real kinematics of the rower against the modeled one.

For kayak, a research work in collaboration with the French Canoe Federation has been carried out to study the influence of some parameters on hull velocity. In this study, a model of loads from the kayaker to his hull was built from on-site measurements with a French elite competitor employing sensors daily used in French team in conjunction with CFD simulations. Influence of some parameters has then been studied by computing the flow around a free hull with these imposed loads coming from the model previously obtained. With this approach, the action of the kayaker on his hull remains unchanged despite modification of his environment, assumption which is questionable. However, we can hope that the trends are meaningful.

CONCLUSION

Simulations in nautical sports are really challenging coupled configurations, especially because a human is part of the system. The need of very accurate models is all the more crucial than elite athletes already operate near an optimal point. Validation is not an easy task but it is an essential phase to have confidence on the results. At term, such models could bring objective and unbiased criteria for questions which have up to now only empirical answers.

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